

Appl. No. 10/808,802  
Amdt. dated 3/21/05  
Reply to Office Action of 01/21/2005

Attorney Docket No.: TS03-186  
N1085-90102

**Amendments to the Claims:**

This listing of claims will replace all prior versions, and listings of claims in the application:

1           1.     (Currently Amended) A method of forming an opening in a stack of  
2 insulator layers, comprising the steps of:

3                 providing a conductive structure;

4                 forming said stack of insulator layer layers on said conductive structure, with said  
5 stack of insulator layers comprised of [[an]] a first liner layer, an overlying first insulator  
6 layer, a second liner layer, an overlying second insulator layer, an anti-reflective coating  
7 (ARC), layer; and a capping, third insulator layer;

8                 forming a via opening in a first portion of said stack of insulator layer, with said  
9 via opening extending downwardly from a top surface of said capping, third insulator  
10 layer and terminating in said first liner layer;

11                 forming a photoresist shape including a trench-defining shape and a photoresist  
12 plug that completely fills said via opening up to said top surface, said trench-defining  
13 shape exposing a second portion of said stack of insulator layers;

14                 forming a trench opening in [[a]] said second portion of said stack of insulator  
15 layers using said trench-defining shape as an etch mask, with said trench opening  
16 extending downwardly from a top surface of said capping, third insulator layer and  
17 terminating on top surface of said second liner layer,

18                 removing portion of said second liner layer exposed in said trench opening;

19                 removing said photoresist shape including said photoresist [[plus]] plug; and

20                 removing a portion of said first liner layer exposed in said via opening, exposing  
21 a portion of a top surface of said conductive structure.

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1           2.     (Original) The method of claim 1, wherein said conductive structure is  
2     comprise of copper.

1           3.     (Original) The method of claim 1, wherein said first liner is a silicon nitride  
2     layer, obtained via plasma enhanced chemical vapor deposition (PECVD) procedures at  
3     a thickness between about 400 to 600 Angstroms.

1           4.     (Original) The method of claim 1, wherein said first insulator layer is a  
2     fluorinated silica glass (FSG) layer, obtained via PECVD procedures at a thickness  
3     between about 500 to 1000 Angstroms.

1           5.     (Original) The method of claim 1, wherein said second liner layer is a  
2     silicon nitride layer, obtained via PECVD procedures at a thickness between about 200  
3     to 400 Angstroms.

1           6.     (Original) The method of claim 1, wherein said second insulator layer is a  
2     silicon oxide layer, obtained via PECVD procedures at a thickness between about 500  
3     to 1000 Angstroms.

1           7.     (Original) The method of claim 1, wherein said ARC layer is a silicon  
2     oxynitride layer, obtained via PRCVD procedures to a thickness between about 500 to  
3     700 Angstroms.

1           8.     (Original) The method of claim 1, wherein said capping, third insulator  
2     layer is a silicon oxide layer, obtained via PECVD procedures at a thickness between  
3     about 500 to 700 Angstroms.

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1           9.     (Original) The method of claim 1, wherein said via opening is defined in  
2     said capping, third insulator layer, in said ARC layer, in said second insulator layer, in  
3     said second liner layer, and in said first insulator layer, via an anisotropic reactive ion  
4     etching (RIE) procedure, using  $\text{CHF}_3$  as an etchant for said capping, third insulator  
5     layer, for said second insulator layer, for said ARC layer and for said first insulator layer,  
6     while  $\text{CH}_x\text{F}_y$  or  $\text{CF}_4$  is used as an etchant for said second liner layer.

1           10.    (Original) The method of claim 1, wherein the diameter of said via  
2     opening is between about 0.25 to 2.5  $\mu\text{m}$ .

1           11.    (Original) The method of claim 1, wherein said trench opening is defined  
2     in said capping, third insulator layer, in said ARC layer, and in second insulator layer via  
3     an anisotropic RIE procedure using  $\text{CHF}_3$  as an etchant.

1           12.    (Original) The method of claim 1, wherein portion of said second liner  
2     layer exposed in said trench opening, is removed via a selective RIE procedure using  
3      $\text{CF}_4$  or  $\text{CH}_x\text{F}_y$  as an etchant.

1           13.    (Previously Presented) The method of claim 1, wherein said photoresist  
2     shape is removed using plasma oxygen ashing procedures.

1           14.    (Original) The method of claim 1, wherein portion of said first liner layer  
2     exposed in said via opening, is removed via a selective RIE procedure using  $\text{CF}_4$  or  
3      $\text{CH}_x\text{F}_y$  as an etchant.

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15. (Original) The method of claim 1, wherein the etch rate ratio of silicon nitride of said first liner layer, to silicon oxide, during the selective RIE procedure used to remove portion of said first liner layer exposed in said via opening, is between about 5 to 1, to 10 to 1 using  $\text{CF}_4$  or  $\text{CH}_x\text{F}_y$  as an etchant.

16. (Currently Amended) A method of forming a dual damascene opening in a stack of insulator layers featuring a two step stop layer removal procedure, comprising the steps of:

providing a copper structure;

forming said stack of insulator layers on said copper structure, with said stack of insulator layers comprised of an underlying first silicon nitride stop layer, an overlying first dielectric layer, a second silicon nitride stop layer, a second dielectric layer, an anti-reflective coating (ARC) layer, and a capping silicon oxide layer;

forming a via opening in a first portion of said stack of insulator layer, with said via opening extending downwardly from a top surface of said capping silicon oxide layer and terminating in said first silicon nitride stop layer;

forming a photoresist shape including a trench-defining shape and a photoresist plug that completely fills said via opening up to said top surface and overlies a portion of a surface of said first silicon nitride layer, said trench-defining shape exposing a second portion of said stack of insulator layers;

~~forming~~ etching to form a trench opening in ~~[[a]]~~ said second portion of said stack of insulator layers using said trench-defining shape as an etch mask, with said trench opening extending downwardly from a top surface of said capping silicon oxide layer and terminating on said surface of said second silicon nitride stop layer;

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20 performing a first step of said two step stop layer removal procedure to  
21 selectively remove a portion of said second silicon nitride stop layer exposed in said  
22 trench opening;

23 removing said photoresist shape including said photoresist plug; and

24 performing a second step of said two step stop layer removal procedure to  
25 remove a portion of said first silicon nitride stop layer exposed in said via opening,  
26 exposing a portion of a top surface of said copper structure.

1 17. (Original) The method of claim 16, wherein said first silicon nitride stop  
2 layer is obtained via plasma enhanced chemical vapor deposition (PECVD) procedures  
3 at a thickness between about 400 to 600 Angstroms.

1 18. (Original) The method of claim 16, wherein said first dielectric layer is an  
2 FSG layer, obtained via PECVD procedures at a thickness between about 500 to 1000  
3 Angstroms.

1 19. (Original) The method of claim 16, wherein said second silicon nitride  
2 stop layer is obtained via PECVD procedures at a thickness between about 200 to 400  
3 Angstroms.

1 20. (Original) The method of claim 16, wherein said second dielectric layer is  
2 a silicon oxide layer, obtained via PECVD procedures at a thickness between about 500  
3 to 1000 Angstroms.

1 21. (Original) The method of claim 16, wherein said ARC layer is a silicon  
2 oxynitride layer, obtained via PECVD procedures to a thickness between about 500 to  
3 700 Angstroms.

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1           22. (Original) The method of claim 16, wherein said capping, silicon oxide  
2 layer is obtained via PECVD procedures at a thickness between about 500 to 700  
3 Angstroms.

1           23. (Original) The method of claim 16, wherein said via opening is defined in  
2 said capping silicon oxide layer, in said ARC layer, in said second dielectric layer, in  
3 said second silicon nitride stop layer, and in said first dielectric layer via an anisotropic  
4 reactive ion etching (RIE) procedure, using  $\text{CHF}_3$  as an etchant for said capping silicon  
5 oxide layer, for said ARC layer and for said second dielectric layer and for said first  
6 dielectric layer, while  $\text{CF}_4$  or  $\text{CH}_x\text{F}_y$  is used as an etchant for said second silicon nitride  
7 stop layer.

1           24. (Original) The method of claim 16, wherein the diameter of said via  
2 opening is between about 0.25 to 2.5  $\mu\text{m}$ .

1           25. (Original) The method of claim 16, wherein said trench opening is defined  
2 in said capping silicon oxide layer, in said ARC layer, and in said second dielectric layer,  
3 via an anisotropic RIE procedure using  $\text{CHF}_3$  as an etchant.

1           26. (Original) The method of claim 16, wherein said first step of said two step  
2 stop layer removal procedure, used to selectively remove portion of said second silicon  
3 nitride stop layer exposed in said trench opening, is performed via a selective RIE  
4 procedure using  $\text{CF}_4$  or  $\text{CH}_x\text{F}_y$  as an etchant.

1           27. (Previously Presented) The method of claim 16, wherein said photoresist  
2 shape is removed using plasma oxygen ashing procedures.

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1           28.   (Original) The method of claim 16, wherein said second step of said two  
2   step stop layer removal procedure, used to selectively remove portion of said first silicon  
3   nitride stop layer exposed in said via opening, is performed via a selective RIE  
4   procedure using  $\text{CF}_4$  or  $\text{CH}_x\text{F}_y$  as an etchant.

1           29.   (Original) The method of claim 16, wherein the etch ratio of silicon nitride  
2   to silicon oxide, during said second step of said two step stop layer removal procedure  
3   performed via a selective the selective RIE procedure used to remove portion of said  
4   first silicon nitride stop layer exposed in said via opening, is between about 5 to 1, to 10  
5   to 1 using  $\text{CF}_4$  or  $\text{CH}_x\text{F}_y$  as an etchant.